

# Greater Manchester's Outline Business Case to tackle Nitrogen Dioxide Exceedances at the Roadside

## Nitrogen Dioxide Diffusion Tube Monitoring Report - 2019



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# 1 Introduction

## 1.1 Background

Jacobs was commissioned by Transport for Greater Manchester (TfGM) to commence a baseline air quality monitoring survey to inform proposed clean air plan measures in January 2018 as part of the Greater Manchester Clean Air Plan (GM CAP). These locations were based on the roads predicted to be in exceedance in 2021 in the “UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations” (Defra, 2017).

Diffusion tubes were placed at roadside locations around Greater Manchester to determine the concentrations of nitrogen dioxide (NO<sub>2</sub>) across the extent of the GM CAP study area. The diffusion tubes were replaced monthly throughout the survey with supply and analysis by Staffordshire Scientific Services.

In June 2019, the diffusion tube survey was extended, and new diffusion tube monitoring sites were installed along roads predicted to be in exceedance as part of the Target Determination modelling process. Additional sites were also included in Manchester city centre where street canyons maybe leading to elevated air pollution concentrations.

These additional monitoring sites were in operation from June to December 2019, accounting for 7-months' worth of monitoring. Therefore, the results shown for these sites have been annualised, to enable a direct comparison with the NO<sub>2</sub> annual mean standard of 40 ug/m<sup>3</sup>.

This report presents the results of the NO<sub>2</sub> diffusion tube monitoring programme for the GM CAP for 2019.

## 1.2 Study Area

The extending of the survey size in June 2019 resulted in monitoring locations in all ten of the Greater Manchester districts; Bolton (BLT), Bury (BUR), Manchester (MAN), Salford (SAL), Stockport (STP), Tameside (TAM), Trafford (TRF) and Wigan (WIG).

## 1.3 Purpose of the Report

The purpose of this report is to:

- set out the methodology for the monitoring survey;
- present the results of the NO<sub>2</sub> diffusion tube monitoring; and

- identify any locations where the measured average annual mean exceeds or is close to exceeding the current standard of  $40 \mu\text{g}/\text{m}^3$  for annual mean  $\text{NO}_2$ .

## 2 Background Information

### 2.1 Topic Definition

Air quality is a description of the concentrations of specific pollutants in ambient air, taking account of the effects of pollution on human health and ecosystems.

The main pollutants of concern around the study area are those emitted by vehicle traffic, primarily NO<sub>2</sub>. NO<sub>2</sub> is a colourless, odourless gas that has been shown to have adverse health effects, including causing respiratory irritation to people with pre-existing conditions, such as asthma. It is formed principally from the oxidation of nitric oxide (NO) through the action of near-surface ozone in the atmosphere. Combustion in air (e.g. in vehicle engines) predominantly forms NO in addition to smaller amounts of NO<sub>2</sub> from the reactions of atmospheric nitrogen and oxygen, with the mixture of NO<sub>2</sub> and NO collectively termed as nitrogen oxides (NO<sub>x</sub>). NO<sub>x</sub> is emitted from internal combustion engines, as well as other forms of combustion, and also has some natural sources, including lightning.

### 2.2 Legislative and Planning Context

The key regulations and policies relevant to air quality in the study area are detailed in Table 2.1.

**Table 2.1 Key air quality legislation and policies**

Legislation	Description
The European Union Directive 2008/50/EC Ambient Air Quality and Cleaner Air for Europe.	<p>These European Directives form the basis for UK air quality legislation. Although published in 2007, the Air Quality Strategy is consistent with The Air Quality Standards Regulations (England) 2010. The European Directives are transposed into UK law which remain binding post-Brexit.</p> <p>The UK government is responsible to the European Commission (EC) for ensuring that it complies with the provisions of the EU Directives. The UK currently is in breach of the limit values for nitrogen dioxide (NO<sub>2</sub>) and PM<sub>10</sub> (particulate matter with an aerodynamic diameter of less than 10 microns).</p>

Legislation	Description
Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019	<p>The EU limit values were transposed into UK law by the Air Quality Standards Regulations 2010 and then slightly modified so the wording accounts for EU exit by the Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019 so still stand as legal limits.</p> <p>On the UK Government's behalf, the Department for Transport and Defra have Public Service Agreements relating to the limit values.</p>
The Air Quality (England) (Amendment) 2000/2002 Regulations.	<p>Legislates for the air quality objectives (AQOs) for pollutants set out in the 2000 Air Quality Strategy, which was revised in 2007 (Defra, 2007).</p> <p>AQOs exist for a variety of pollutants including NO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>. These are established for both the protection of human health and the protection of vegetation and ecosystems.</p>
Environment Act 1995, Part IV.	<p>Introduced a system of local air quality management (LAQM) in the UK, which requires local authorities to review and assess air quality within their boundaries regularly and systematically against AQOs. Local Authorities must appraise development and transport plans against these objectives and make plans to meet the AQOs where they are exceeded.</p>
The Air Quality Standards 2010	<p>These regulations set out the assessment criteria of ambient air quality, contain a duty to meet limit values and give the secretary of state powers to give directions to local authorities.</p>

Ambient NO<sub>2</sub> concentrations are subject to the UK Air Quality Objectives (AQOs) and Limit Values outlined in Table 2.2. To determine compliance with the NO<sub>2</sub> 1-hour mean AQO and Limit Value, research undertaken on behalf of Defra (Defra, 2018), identified that road traffic emission related exceedances of the NO<sub>2</sub> 1-hour mean AQO are unlikely to occur where the annual mean is below 60 µg/m<sup>3</sup>.

**Table 2.2 Air Quality Objective / Limit Value for NO<sub>2</sub>**

Pollutant	Period/Statistic	AQO / Limit Value (µg/m <sup>3</sup> )
NO <sub>2</sub> (for human health)	Annual mean	40
	1-hour mean, not to be exceeded more than 18 times per year (equivalent to the 99.79 <sup>th</sup> percentile of 1-hour means)	200

The government considers the concentration-based standards at integer values, and therefore exceedance of the annual mean 40 µg/m<sup>3</sup> standard occurs when >40.4 µg/m<sup>3</sup> because data should be reported to 1 decimal place and therefore would round to 41 ug/m<sup>3</sup> as an integer.



### 3 Methodology

#### 3.1 Diffusion Tubes

The use of diffusion tubes is a simple way to measure air quality and gives an indication of average pollution concentrations over a time period ranging from one to five weeks. They are a type of passive sampler, whereby the air flow is controlled by natural diffusion and does not involve the pumping of any air. The tubes are 71mm long with an internal diameter of 11mm and contain two stainless steel gauzes at one end. These contain an absorbent (triethanolamine (TEA)) that traps the NO<sub>2</sub> and converts it to nitrite (NO<sub>2</sub><sup>-</sup>), which is then analysed in an accredited laboratory. The other end of the tube is left open to the atmosphere, facing downward to prevent contamination by rain or dust. To ensure that the tubes do not collect any pollutant after leaving their site location they are sealed before their journey to the laboratory.

The low cost of the tubes, and simplicity of installation, enables sampling at a number of locations within an area of interest. This is useful in highlighting 'hotspots' of high concentrations where more detailed studies may be required.

NO<sub>2</sub> diffusion tubes are an indicative monitoring technique and may exhibit biases relative to continuous analysers, with positive bias being more common than negative (Defra, 2008). Bias adjustments are therefore applied to the tubes as described in Section 3.4 of this report. Factors that can cause under- and over-estimation of diffusion tube NO<sub>2</sub> concentrations include:

- the tube location;
- meteorology, i.e. wind turbulence at the open end of the tube;
- blocking of UV light by the tube material;
- interference from peroxyacetyl nitrate (PAN); and
- handling during laboratory analysis.

The diffusion tubes were supplied by Staffordshire Scientific Services and prepared using 20% triethanolamine (TEA) in water. Technical Guidance Note LAQM.TG(16) issued by Defra (2018) requires diffusion tubes results to be adjusted for bias against a continuous monitoring chemiluminescence analyser.

### 3.2 Monitoring Locations

The 12-month monitoring survey took place over 58 monitoring locations in 2019, accounting for a total of 64 diffusion tubes per month (including 3 sites of triplicate diffusion tubes co-located at continuous monitoring sites).

In June 2019, 170 new diffusion tubes were installed at 168 locations across Greater Manchester, bringing the total number of diffusion tubes to 234 across 226 locations (including 4 sites of triplicate diffusion tubes co-located at continuous monitoring sites). A further description of the site locations is provided in Appendix B.

During each changeover period of the 12-month survey, a travel blank and one office blank was used to identify possible contamination of diffusion tubes whilst in transit or storage. When the monitored area increased, four travel blanks (one for the North, two for the South and one for the City Centre sites) – not exposed to pollutants – travelled with all other diffusion tubes. The travel blanks were taken to the site when the tubes were installed but returned to the office storage for the duration of the exposure period. The travel blanks were taken to the site again when the tubes were collected, after the exposure period. One office blank was used for each monitoring period, which remained in storage at all times and did not travel to and from the site. The travel and office blanks were sent to the Staffordshire Scientific Services laboratory for analysis along with the exposed tubes. The results of travel and office blanks were used to identify any potential contamination issues.

### 3.3 Monitoring timescales

The diffusion tubes were changed monthly for a period of 12 months (at the existing locations) and 7 months (at the new locations). The tubes were changed over a period of two days at the start of each monthly exposure period, hence there is an overlap of one day between each period. The start and end dates for each monthly exposure period are shown in Table 3.1. Time weighted average concentrations (i.e. period weighted mean concentrations) have been calculated to account for variability in the number of exposure days over each monthly period.

**Table 3.1 Start and end dates for monthly monitoring periods**

Monitoring period for existing sites	Monitoring period for new sites	Month	Start date	End date	Number of days
P1	N/A	January	15 <sup>th</sup> January 2019	15 <sup>th</sup> February 2019	31
P2	N/A	February	14 <sup>th</sup> February 2019	15 <sup>th</sup> March 2019	29
P3	N/A	March	14 <sup>th</sup> March 2019	18 <sup>th</sup> April 2019	35
P4	N/A	April	17 <sup>th</sup> April 2019	16 <sup>th</sup> May 2019	29
P5	N/A	May	15 <sup>th</sup> May 2019	18 <sup>th</sup> June 2019	34
P6	P1	June	17 <sup>th</sup> June 2019	18 <sup>th</sup> July 2019	31
P7	P2	July	17 <sup>th</sup> July 2019	16 <sup>th</sup> August 2019	30
P8	P3	August	15 <sup>th</sup> August 2019	18 <sup>th</sup> September 2019	34
P9	P4	September	17 <sup>th</sup> September 2019	22 <sup>nd</sup> October 2019	35
P10	P5	October	17 <sup>th</sup> October 2019	20 <sup>th</sup> November 2019	34
P11	P6	November	18 <sup>th</sup> November 2019	18 <sup>th</sup> December 2019	30
P12	P7	December	17 <sup>th</sup> December 2019	17 <sup>th</sup> January 2020	31

### 3.4 Bias adjustment

In accordance with LAQM.TG(16), there is a choice of applying either a national bias adjustment factor or a local bias adjustment, calculated by co-locating tubes with local continuous monitoring sites. The national bias adjustment factor is calculated using the LAQM National Diffusion Tube Bias Adjustment Factor Spreadsheet (March 2020). Bias adjustment factors are collated in a national database from a number of co-location

studies, allowing the bias at a range of site locations with consistent analysis methods (laboratory and analysis technique) to be considered. This study applies the 2019 national bias adjustment factor of 0.93 to the raw monitored diffusion tube concentrations.

Diffusion tubes were also co-located at the Trafford A56 (TRF2), Stockport Hazel Grove (STK5), Bury Radcliffe (BUR1) and Manchester Oxford Road (MAN1) continuous monitoring sites to determine a local bias adjustment. Continuous monitoring site concentrations were obtained from the Air Quality England (2019) website. At each of the four sites, the NO<sub>2</sub> concentrations from the continuous analysers were compared with the co-located tube concentrations over the monitoring period. A summary of the results is given in Table 3.2. Based on the ratio of the continuous analyser concentrations to the diffusion tube concentrations, a local bias adjustment factor was calculated to be 0.95. This was therefore consistent with the national bias adjustment factor that was applied herein.

**Table 3.2 Comparison of NO<sub>2</sub> concentrations for the continuous analysers and co-located diffusion tubes (µg/m<sup>3</sup>) and data capture (%)**

Site	Monitoring technique	Monitoring period average (µg/m <sup>3</sup> ) – mean followed by individual tubes	Data capture (%) – mean followed by individual tubes
Trafford A56 (TRF2 a,b,c) <sup>1</sup>	Co-location diffusion tubes	36 (a: 33.6, b: 36.2, c: 38)	92 (a: 100, b: 83, c: 92)
	Continuous monitoring*	29.4	99
Stockport Hazel Grove (STK5 a,b,c) <sup>2</sup>	Co-location diffusion tubes	27.2 (a: 27.4, b: 26.6, c: 27.7)	97 (a: 100, b: 92, c: 100)
	Continuous monitoring*	22.3	96
Bury Radcliffe (BUR1 a,b,c) <sup>3</sup>	Co-location diffusion tubes	29.2 (a: 31, b: 31.4, c: 25.3)	72 (a: 83, b: 75, c: 58)
	Continuous monitoring*	26.6	99
Manchester Oxford Road (MAN-1 a,b,c) <sup>4</sup>	Co-location diffusion tubes	45 (a: 45.1, b: 45.8)**	100 (a: 100, b: 100)
	Continuous monitoring*	52.6	98

\*Ratification of continuous monitoring data: TRF2, STK5, BUR1 and MAN-1 are ratified up to 31<sup>st</sup> December 2019. Data is provisional thereafter.

\*\*Only two tubes at this site used for bias calculation as third tube had less than 75% data capture. Data annualised as part of 7 month survey.

### 3.5 Annualisation of 7-Month Diffusion Tube Survey

LAQM.TG(16) (Defra, 2018) states that if monitoring data has been obtained for between 25% and 75% of the year, then annualisation techniques can be used to estimate an annual average from a part year average. The data from the 7-month

<sup>1</sup> Web source: [http://www.airqualityengland.co.uk/site/data.php?site\\_id=TRF2](http://www.airqualityengland.co.uk/site/data.php?site_id=TRF2)

<sup>2</sup> Web source: [http://www.airqualityengland.co.uk/site/latest?site\\_id=STK5](http://www.airqualityengland.co.uk/site/latest?site_id=STK5)

<sup>3</sup> Web source: [http://www.airqualityengland.co.uk/site/latest?site\\_id=BUR1](http://www.airqualityengland.co.uk/site/latest?site_id=BUR1)

<sup>4</sup> Web source: [https://www.airqualityengland.co.uk/site/latest?site\\_id=MAN1](https://www.airqualityengland.co.uk/site/latest?site_id=MAN1)

study (between June and December 2019) was annualised to an annual mean using the guidance outlined in LAQM.TG(16) to provide data representative of the year 2019.

### 3.6 Study Limitations

Diffusion tubes with data capture of 75% and above are considered to give a reliable representation of NO<sub>2</sub> concentrations over both the 12-month study and 7-month (annualised) study.

As the diffusion tubes are accessible to the public and to outdoor conditions there is always a possibility that they can become misplaced (e.g. stolen, vandalised etc) between site visits. This has resulted in reduced data capture at several monitoring locations.

Monthly tube collections at some of the Manchester (tubes MAN 4-3 and 4-2) and Salford (SAL 1-5) sites were hampered by roadworks and inaccessible at the start of the 2019 survey. As a result, several tubes were removed and access to other tube locations was restricted during certain site visits; therefore, the data capture at these monitoring locations was below 75% over the 12-month monitoring period.

The BLT 1-5 diffusion tube became inaccessible in month five due to overgrown vegetation, resulting in the data capture at this site being below 75%.

## 4 Monitoring Results

All tubes were provided and analysed by the same laboratory and NO<sub>2</sub> concentrations calculated for each tube based on individual exposure times. No data was provided for missing tubes and any low readings were checked with the laboratory for justification. The full raw and bias adjusted results are presented in Appendix C.

The bias adjusted annual mean NO<sub>2</sub> concentrations for 2019 at all monitoring locations (of those with data capture greater than 75%) for the 12-month survey and the additional 7-month survey are presented in Tables 4.1 and 4.2, respectively; this excludes sites co-located at continuous monitoring stations.

The average NO<sub>2</sub> concentrations are shown in bold and underlined where concentrations exceed annual mean NO<sub>2</sub> concentrations of 40.4 µg/m<sup>3</sup>. Concentrations are also underlined where concentrations exceed 35 µg/m<sup>3</sup> which is the concentration used to define the Greater Manchester Air Quality Management Area (i.e. where locations should be considered at risk of exceeding the annual mean standard).

**Table 4.1 National bias-adjusted annual mean NO<sub>2</sub> results for the 2019 12-month survey**

Site	National bias-adjusted 2019 mean NO <sub>2</sub> concentration (µg/m <sup>3</sup> )	Data capture (%)
BLT 1-1	<b><u>49.3</u></b>	92
BLT 1-2	32.6	100
BLT 1-3	34.3	100
BLT 1-4	<u>36.9</u>	75
BUR 1-1	31.7	92
BUR 1-2	<b><u>44.5</u></b>	92
BUR 1-3	<u>36.6</u>	92
BUR 1-4	<u>39.0</u>	100
BUR 1-5	<b><u>43.6</u></b>	83
MAN 1-1	<u>35.7</u>	100

Site	National bias-adjusted 2019 mean NO <sub>2</sub> concentration (µg/m <sup>3</sup> )	Data capture (%)
MAN 1-2	<u>35.8</u>	92
MAN 1-3	<b><u>50.1</u></b>	100
MAN 1-5	<b><u>41.1</u></b>	100
MAN 2-1	<b><u>45.3</u></b>	100
MAN 2-2	<u>40.1</u>	100
MAN 2-3	<b><u>43.8</u></b>	75
MAN 2-5	<b><u>64.1</u></b>	100
MAN 3-1	<u>39.2</u>	92
MAN 3-2	<u>36.2</u>	100
MAN 3-3	<u>37.7</u>	83
MAN 3-4	<b><u>43.9</u></b>	100
MAN 3-5	<b><u>41.6</u></b>	92
MAN 4-1	<b><u>43.2</u></b>	92
MAN 4-4	<b><u>43.4</u></b>	92
MAN 4-5	<b><u>55.0</u></b>	83
SAL 1-4	<b><u>44.4</u></b>	92
STP 1-1	<b><u>53.9</u></b>	100
STP 1-2	<b><u>53.7</u></b>	92
STP 1-3	<u>36.2</u>	100
STP 1-4	<b><u>44.5</u></b>	92
STP 1-5	<b><u>53.3</u></b>	100
STP 2-1	<b><u>53.7</u></b>	83
STP 2-2	33.9	75



Site	National bias-adjusted 2019 mean NO <sub>2</sub> concentration (µg/m <sup>3</sup> )	Data capture (%)
STP 2-3	<u>39.0</u>	100
STP 2-4	<b><u>51.3</u></b>	100
STP 2-5	<b><u>46.8</u></b>	83
TAM 1-1	<u>37.8</u>	83
TAM 1-2	<b><u>49.0</u></b>	100
TAM 1-3	<b><u>44.8</u></b>	92
TAM 1-4	<b><u>55.6</u></b>	100
TAM 1-5	<b><u>41.1</u></b>	83
TRF 1-1	<u>38.2</u>	75
TRF 1-2	<u>37.6</u>	100
TRF 1-3	<b><u>47.4</u></b>	100
TRF 1-4	<u>35.1</u>	83
TRF 1-5	<u>39.1</u>	100

Of the 46 monitored tube locations from the 12-month survey presented in Table 4.1, 26 locations measured NO<sub>2</sub> concentrations exceeding 40.4 µg/m<sup>3</sup>. This included 11 tubes over the central Manchester and Salford region (two tubes at MAN 1, three at MAN 2, two at MAN 3 and three at MAN 4) and one tube in Salford (SAL 1-4), 7 tubes in Stockport (four tubes at STP 1 and three tubes at STP 2). Concentrations over 40.4 µg/m<sup>3</sup> were also recorded for four locations in Tameside (TAM 1), one location in Bolton (BLT 1-1), two locations in the Bury region (BUR 1) and one in Trafford (TRF 1-3). In addition, 16 tubes recorded concentrations between 35 µg/m<sup>3</sup> and 40.4 µg/m<sup>3</sup>, therefore these are considered at risk of exceeding the NO<sub>2</sub> AQO. One site, MAN 2-5, recorded NO<sub>2</sub> concentrations above 60 µg/m<sup>3</sup>, indicating the possibility of the 1-hourly mean standard being exceeded at this location.

**Table 4.2 National bias-adjusted and annualised mean NO<sub>2</sub> results for the 2019 7-month survey**

Site	Annualised and national bias-adjusted 2019 annual mean concentration (µg/m <sup>3</sup> ) (where data capture is >75%)	Data capture (%)
BLT-A3	<u>39.8</u>	86
BLT-A5	<u>48.5</u>	100
BLT-A6	<u>47.6</u>	86
BLT-B2	<u>64.3</u>	100
BUR-A1	<u>49.6</u>	100
BUR-A2	<u>59.1</u>	86
BUR-A3	<u>48.5</u>	100
BUR-A4	<u>61.5</u>	100
BUR-A5	<u>55.3</u>	100
BUR-B1	<u>62.1</u>	100
BUR-B2	<u>44.9</u>	86
BUR-B3	<u>36.4</u>	100
BUR-D1	<u>55.9</u>	86
BUR-D2	<u>55.4</u>	86
BUR-D3	<u>42.1</u>	100
MAN-A1	<u>55.4</u>	86
MAN-A3	<u>59.7</u>	86
MAN-A4	<u>54.1</u>	86
MAN-A5	<u>53.3</u>	100
MAN-A7	<u>53.9</u>	86

Site	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ ) (where data capture is >75%)	Data capture (%)
MAN-A8	<u>55.9</u>	86
MAN-B3	<u>63.0</u>	100
MAN-B4	<u>57.8</u>	86
MAN-B5	<u>65.7</u>	100
MAN-B6	<u>60.2</u>	86
MAN-C1	<u>42.5</u>	100
MAN-C3	<u>62.7</u>	100
MAN-C4	<u>64.6</u>	100
MAN-C5	<u>66.3</u>	100
MAN-D1	<u>56.5</u>	100
MAN-D2	<u>48.0</u>	86
MAN-D3	<u>59.1</u>	86
MAN-D4	<u>46.9</u>	100
MAN-E2	<u>52.2</u>	100
MAN-E3	<u>48.6</u>	100
MAN-F1	<u>56.4</u>	100
MAN-F2	<u>68.1</u>	86
MAN-F3	<u>50.7</u>	86
MAN-G1	<u>56.4</u>	86
MAN-G2	<u>60.9</u>	100
MAN-G3	<u>56.1</u>	100
MAN-H2	<u>50.2</u>	100

Site	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ ) (where data capture is >75%)	Data capture (%)
MAN-J1	<u>42.7</u>	100
MAN-J2	<u>49.5</u>	100
MAN-J5	<u>46.9</u>	100
MAN-J7	<u>51.6</u>	100
MAN-J8	<u>61.9</u>	86
MAN-K1	<u>43.6</u>	100
MAN-K2	<u>49.4</u>	100
MAN-K3	<u>50.9</u>	86
MAN-L1	<u>56.4</u>	86
MAN-L2	<u>44.1</u>	100
MAN-L4	<u>43.8</u>	100
MAN-M3	<u>61.6</u>	100
MAN-M4	<u>54.1</u>	100
MAN-N2	<u>47.1</u>	100
MAN-N3	<u>44.1</u>	100
MAN-N4	<u>57.1</u>	100
MAN-N5	<u>66.3</u>	100
MAN-P1	<u>48.2</u>	86
MAN-P2	<u>63.5</u>	100
MAN-P3	<u>46.9</u>	100
MAN-P4	<u>55.2</u>	86
MAN-Q1	<u>52.5</u>	86

Site	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ ) (where data capture is >75%)	Data capture (%)
MAN-Q2	<u>55.3</u>	100
MAN-Q5	<u>46.4</u>	100
MAN-S1	<u>43.1</u>	86
MAN-S2	<u>45.9</u>	86
MAN-S3	<u>53.1</u>	86
MAN-T1	<u>53.2</u>	100
MAN-T2	<u>56.1</u>	100
MAN-T3	<u>69.7</u>	100
MAN-T4	<u>60.6</u>	100
MAN-T5	<u>75.9</u>	100
MAN-T6	<u>67.6</u>	100
MAN-U1	<u>54.4</u>	100
MAN-U2	<u>57.6</u>	86
MAN-U3	30.3	100
OLD-A1	<u>37.1</u>	100
OLD-A3	<u>50.9</u>	100
OLD-A4	<u>53.9</u>	100
OLD-A6	<u>50.4</u>	100
OLD-B2	<u>46.9</u>	86
OLD-B3	<u>53.8</u>	100
ROC-A4	<u>45.3</u>	100
ROC-A5	<u>60.7</u>	86

Site	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ ) (where data capture is >75%)	Data capture (%)
ROC-B2	<u>46.2</u>	86
ROC-B4	<u>40.1</u>	100
ROC-B5	<u>38.5</u>	86
SAL-A2	<u>54.3</u>	86
SAL-A4	<u>43.5</u>	100
SAL-A5	<u>54.3</u>	100
SAL-B2	<u>45.4</u>	100
SAL-B3	<u>47.0</u>	86
SAL-C1	<u>41.1</u>	100
SAL-C3	<u>66.7</u>	86
STP-A2	<u>43.5</u>	100
STP-A3	<u>48.3</u>	100
STP-A4	<u>40.5</u>	100
STP-A5	<u>47.3</u>	86
STP-A6	<u>75.3</u>	86
STP-B1	<u>46.2</u>	100
STP-B2	<u>49.0</u>	100
STP-B3	<u>44.3</u>	86
TAM-A1	<u>52.6</u>	100
TAM-B1	<u>39.6</u>	86
TAM-B3	<u>39.0</u>	86
TAM-C1	<u>45.5</u>	100

Site	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ ) (where data capture is >75%)	Data capture (%)
TRF-A2	<u>34.1</u>	86
TRF-A3	<b><u>44.2</u></b>	86
TRF-B1	<u>36.2</u>	100
TRF-B2	<u>35.9</u>	100
TRF-B3	<u>39.2</u>	86
TRF-C1	<b><u>41.0</u></b>	86
WIG-B2	<b><u>45.2</u></b>	86
WIG-C1	<u>40.2</u>	100

Of the 116 monitored tube locations from the 7-month survey presented in Table 4.2, 103 locations measured  $\text{NO}_2$  concentrations exceeding  $40.4 \mu\text{g}/\text{m}^3$ . This includes tubes located in Bolton (BLT-A and BLT-B), Bury (BUR-A, BUR-B and BUR-D), Central Manchester and Salford (MAN-A, MAN-B, MAN-C, MAN-D, MAN-E, MAN-F, MAN-G, MAN-H, MAN-J, MAN-K, MAN-L, MAN-M, MAN-N, MAN-P, MAN-Q, MAN-S, MAN-T, MAN-U, SAL-A, SAL-B and SAL-C), Oldham (OLD-A and OLD-B), Rochdale (ROC-A and ROC-B), , Stockport (STP-A and STP-B), Tameside (TAM-A and TAM-C), Trafford (TRF-A and TRF-C) and Wigan (WIG-B).

In addition, 11 tubes recorded concentrations between  $35 \mu\text{g}/\text{m}^3$  and  $40.4 \mu\text{g}/\text{m}^3$ , therefore these sites are considered at risk of exceeding the  $\text{NO}_2$  annual mean standard. Furthermore, 22 sites (BLT-B2, BUR-A4, BUR-B1, MAN-B3, MAN-B5, MAN-B6, MAN-C3, MAN-C4, MAN-C5, MAN-F2, MAN-G2, MAN-J8, MAN-M3, MAN-N5, MAN-P2, MAN-T3, MAN-T4, MAN-T5, MAN-T6, ROC-A5, SAL-C3 and STP-A6) recorded  $\text{NO}_2$  concentrations above  $60 \mu\text{g}/\text{m}^3$ , indicating the possibility of the 1-hourly mean standard being exceeded at these locations.

## 5 Discussion

This monitoring survey indicates that NO<sub>2</sub> concentrations are likely to be in exceedance of the annual mean standard of 40 µg/m<sup>3</sup> at 129 locations around Greater Manchester, with a further 27 locations considered to be at risk of exceeding the standard.

An annual mean benchmark of 60 µg/m<sup>3</sup> is utilised for indicating the potential exceedance of the short term 1- hour mean standard (200 µg/m<sup>3</sup>), as discussed in section 2.2. The 1-hour mean NO<sub>2</sub> standard has the potential to have been exceeded at 23 sites (MAN 2-5, BLT-B2, BUR-A4, BUR-B1, MAN-B3, MAN-B5, MAN-B6, MAN-C3, MAN-C4, MAN-C5, MAN-F2, MAN-G2, MAN-J8, MAN-M3, MAN-N5, MAN-P2, MAN-T3, MAN-T4, MAN-T5, MAN-T6, ROC-A5, SAL-C3 and STP-A6), where the annual mean NO<sub>2</sub> concentrations have exceeded 60 µg m<sup>3</sup>.



## **6 Conclusions**

Throughout 2019, a 12-month diffusion tube survey – including additional sites commencing in June 2019 – was carried out at a total of 226 monitoring locations around Greater Manchester to inform the proposed GM CAP study. The monitoring survey provides measurements of annual mean NO<sub>2</sub> concentrations within all ten Greater Manchester local authorities.

The results indicate that NO<sub>2</sub> concentrations are likely to be in exceedance of an annual mean standard of 40 µg/m<sup>3</sup> at 129 locations around Greater Manchester, with a further 27 locations considered to be at risk of exceeding this standard.

Additionally, exceedances of the one-hour mean standard were possible at 23 sites (MAN 2-5, BLT-B2, BUR-A4, BUR-B1, MAN-B3, MAN-B5, MAN-B6, MAN-C3, MAN-C4, MAN-C5, MAN-F2, MAN-G2, MAN-J8, MAN-M3, MAN-N5, MAN-P2, MAN-T3, MAN-T4, MAN-T5, MAN-T6, ROC-A5, SAL-C3 and STP-A6), based on observed annual mean concentrations above 60 µg m<sup>3</sup>.

## **7 References**

Air Quality England (2020). Local Authority Summary [Online]. [Accessed March 2020]. Available from: <http://www.airqualityengland.co.uk>

Air Quality Standards (England) Regulations 2010

Air Quality (England) (Amendment) 2000 / 2002 Regulations

Defra (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Volume 1

Defra (2008). – Diffusion Tubes for Ambient NO<sub>2</sub> Monitoring: Practical Guidance AEA/ENV/R/2504 – Issue 1a

Defra and the Department for Transport (2017). UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations: Detailed Plan

Defra (2018). Local Air Quality Management. Technical Guidance LAQM.TG(16). April 2018

Defra (2020). LAQM National Diffusion Tube Bias Adjustment Factor Spreadsheet (03/20) [online]. [Accessed March 2020]. Available from: <https://laqm.defra.gov.uk/bias-adjustment-factors/national-bias.html>

Environment Act (1995). HMSO

European Commission (2008) European Union (EU) Directive 2008/50/EC on ambient air quality and cleaner air for Europe (CAFÉ), 21st May 2008

## Appendix A. Abbreviations

AQO	Air Quality Objective
AQ	Air Quality
AQMA	Air Quality Management Area
AURN	Automatic Urban and Rural Network
Defra	Department of Environment Food and Rural Affairs
LAQM	Local Air Quality Management
LAQM.TG(16)	Local Air Quality Management Technical Guidance 2016
NO <sub>2</sub>	Nitrogen Dioxide
NO	Nitrogen Monoxide
NO <sub>x</sub>	Oxides of Nitrogen (NO <sub>2</sub> + NO)
TEA	Triethanolamine
EU	European Union
EC	European Commission

## Appendix B. Diffusion Tube Locations

Table B.1 Initial 2018 survey diffusion tube locations

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
BUR1 (a,b,c)	A665 (Water Street)	378204	407480	4.5	1.6
BLT 1-1	A666 (St Peters Way)	373078	407332	On railing, elevated above roadside (no data)	1.7
BLT 1-2	A666 (St Peters Way)	372414	408758	Long distance from kerbside- (no data)	1.9
BLT 1-3	A666 (St Peters Way)	372899	407651	2.0	2.3
BLT 1-4	A666 (St Peters Way)	372422	408629	2.3	1.8
BLT 1-5	A666 (St Peters Way)	372631	408264	3.0	1.2
BUR 1-1	A58 (Bolton Road)	379355	410630	2.5	2.1
BUR 1-2	A58 (Bolton Road)	379851	410974	0.9	1.9
BUR 1-3	A58 (Bolton Road)	379918	410926	1.3	2.2
BUR 1-4	A58 (Bolton Road)	379822	410944	0.8	2.1
BUR 1-5	A58 (Bolton Road)	379549	410802	2.0	2.3
MAN 1-1	A5103 (Princess Parkway)	382637	391216	1.1	2.5
MAN 1-2	A5103 (Princess Parkway)	382726	391364	3.0	2.5
MAN 1-3	A5103 (Princess Parkway)	382854	391602	2.0	2.2
MAN 1-4	A5103 (Princess Parkway)	382971	391822	2.6	2.4
MAN 1-5	A5103 (Princess Parkway)	382793	391431	2.2	2.2
MAN 2-1	A57 (M) (Mancunian Way)	383370	397133	2.5	2.3
MAN 2-2	A57 (M) (Mancunian Way)	383637	397097	7.3	2.5
MAN 2-3	A57 (M) (Mancunian Way)	383855	397070	1.4	2.3
MAN 2-4	A57 (M) (Mancunian Way)	383273	397147	1.8	1.2
MAN 2-5	A57 (M) (Mancunian Way)	383357	397166	1.8	1.3
MAN 3-1	A635 (Mancunian Way)	385291	397454	7.3	2.4

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
MAN 3-2	A635 (Mancunian Way)	385352	397461	7.3	2.6
MAN 3-3	A635 (Mancunian Way)	385400	397487	1.3	2.4
MAN 3-4	A635 (Mancunian Way)	385271	397427	1.4	2.4
MAN 3-5	A635 (Mancunian Way)	385119	397457	1.0	2.1
MAN 4-1	A57 (M) (Mancunian Way)	382842	397408	0.5	2.0
MAN 4-2	A57 (M) (Mancunian Way)	382756	397571	0.7	2.3
MAN 4-3	A57 (M) (Mancunian Way)	382770	397613	0.6	2.4
MAN 4-4	A57 (M) (Mancunian Way)	382884	397414	0.2	2.3
MAN 4-5	A57 (M) (Mancunian Way)	382828	397501	2.3	2.4
SAL 1-1	A57 (Regent Road)	382407	397762	2.6	2.4
SAL 1-2	A57 (Regent Road)	382571	397719	1.5	2.3
SAL 1-3	A57 (Regent Road)	382321	397758	2.0	2.3
SAL 1-4	A57 (Regent Road)	382592	397688	2.5	2.2
SAL 1-5	A57 (Regent Road)	382397	397738	2.5	2.3
STK5 (a,b,c)	A6 (London Road)	391482	387638	5.2	2.6
STP 1-1	A34 (Kingsway)	385324	387412	2.8	2.4
STP 1-2	A34 (Kingsway)	385247	387620	2.9	2.5
STP 1-3	A34 (Kingsway)	385118	387954	2.0	2.2
STP 1-4	A34 (Kingsway)	385081	388171	7.3	2.5
STP 1-5	A34 (Kingsway)	385380	387258	2.3	2.1
STP 2-1	A34 (Kingsway)	385016	388520	0.6	2.4
STP 2-2	A34 (Kingsway)	385048	388888	2.2	3.3
STP 2-3	A34 (Kingsway)	385052	388779	0.6	2.4
STP 2-4	A34 (Kingsway)	385043	388635	1.8	2.3
STP 2-5	A34 (Kingsway)	385078	389157	On bridge over motorway (no data)	***
TAM 1-1	A635 (Manchester Road)	392768	398502	3.0	2.4
TAM 1-2	A635 (Manchester Road)	393040	398602	2.5	2.0
TAM 1-3	A635 (Manchester Road)	392586	398405	3.3	2.3

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
TAM 1-4	A635 (Manchester Road)	393000	398603	1.4	2.0
TAM 1-5	A635 (Manchester Road)	392541	398419	2.0	2.2
TRF 1-1	A56 (Chester Road)	379268	393579	1.7	1.2
TRF 1-2	A56 (Chester Road)	379352	393804	2.0	1.2
TRF 1-3	A56 (Chester Road)	379209	393467	1.7	2.0
TRF 1-4	A56 (Chester Road)	379313	393769	3.5	2.1
TRF 1-5	A56 (Chester Road)	379239	393597	7.3	1.9
TRF2 (a,b,c)	A56 (Chester Road)	379414	394016	7.3	2.5

"a,b,c" indicates triplicate diffusion tubes

**Table B.2 New diffusion tube locations from June 2019 survey extension**

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
BLT-A1	A579 (Trinity Street)	371833	408713	2.8	2.0
BLT-A2	A676 (Moor Lane)	371349	408942	1.6	2.0
BLT-A3	B6205 (Marsden Road)	371279	409376	2.6	2.0
BLT-A4	A673 (St Georges Road)	371103	409568	2.7	2.0
BLT-A5	A673 (Topp Way)	371429	409660	2.2	2.0
BLT-A6	A673 (Topp Way)	371747	409769	1.9	2.0
BLT-B1	A666 (Bolton Road)	374918	405022	2.3	2.0
BLT-B2	A666 (Bolton Road)	374639	405172	2.0	2.0
BLT-B3	A6053 (Bolton Road)	374345	405361	1.7	2.0
BUR-A1	A56 (Bury New Road)	381138	404194	0.7	2.0
BUR-A2	A56 (Bury New Road)	381085	404275	2.6	2.0
BUR-A3	A56 (Bury New Road)	380917	404886	2.4	2.0
BUR-A4	A56 (Bury New Road)	380888	404927	2.4	2.0
BUR-A5	A56 (Bury New Road)	380877	405085	2.2	2.0
BUR-B1	A576 (Middleton Road)	384152	404624	2.7	2.0
BUR-B2	A576 (Middleton Road)	384533	405037	1.4	2.0
BUR-B3	A576 (Manchester Old Road)	384772	405108	3.3	2.0
BUR-C1	B6213 (Crosthons Road)	379631	411060	3.7	2.0

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
BUR-C2	B6213 (Tottenham Road)	379591	411239	2.0	2.0
BUR-C3	B6214 (Brandlesholme Road)	379678	411341	1.5	2.0
BUR-D1	A58 (Rochdale Road)	381666	410686	0.4	2.0
BUR-D2	A58 (Rochdale Road)	381939	410632	1.4	2.0
BUR-D3	A58 (Bury New Road)	382305	410531	2.4	2.0
MAN-1 (a,b,c)	A34 (Oxford Road)	384234	397287	0.8	1.7
MAN-A1	A56 (Deansgate)	383578	398122	0.4	2.2
MAN-A2	A56 (Deansgate)	383563	398039	2.4	2.0
MAN-A3	A56 (Deansgate)	383609	398217	5.2	2.1
MAN-A4	A56 (Deansgate)	383663	398338	3.5	2.2
MAN-A5	A56 (Deansgate)	383687	398366	1.6	2.3
MAN-A6	A56 (Deansgate)	383718	398438	1.3	2.2
MAN-A7	A56 (Deansgate)	383733	398512	0.7	2.1
MAN-A8	A56 (Deansgate)	383784	398585	2.2	2.1
MAN-B1	A34 (Bridge Street)	383417	398337	1.9	2.4
MAN-B2	A34 (Bridge Street)	383518	398289	1.4	2.2
MAN-B3	A34 (Bridge Street)	383605	398276	0.7	2.2
MAN-B4	A34 (John Dalton Street)	383660	398245	2.5	2.1
MAN-B5	A34 (John Dalton Street)	383703	398241	0.7	2.0
MAN-B6	A34 (John Dalton Street)	383759	398208	0.8	2.2
MAN-C1	A56 (Victoria Bridge Street)	383764	398727	2.7	2.2
MAN-C2	A56 (Victoria Bridge Street)	383754	398718	2.2	2.0
MAN-C3	Lastingham Green	384128	398671	2	2.4
MAN-C4	Shudehill	384329	398777	1.7	2.3
MAN-C5	Shudehill	384396	398811	2.1	2.3
MAN-D1	Church Street	384349	398504	0.7	2.2
MAN-D2	Church Street	384280	398505	4.4	2.2
MAN-D3	High Street	384260	398590	0.5	2.2
MAN-D4	Fountain Street	384160	398343	2.8	2.3

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
MAN-E1	Oxfield Court	383881	398288	0.7	2.3
MAN-E2	Arlington Way	383964	398261	0.7	2.3
MAN-E3	Spring Gardens	384038	398270	2.1	2.2
MAN-F1	Parker Street	384289	398236	1.6	2.4
MAN-F2	A62 (Lever Street)	384482	398321	2.5	2.2
MAN-F3	A62 (Lever Street)	384649	398545	3.2	2.3
MAN-G1	B6181 (Ducie Street)	384712	398093	0.5	2.2
MAN-G2	Auburn Street	384585	398020	0.5	2.2
MAN-G3	A6 (Aytoun Street)	384563	397937	3.5	2.4
MAN-H1	A635 (Fairfield Street)	385589	397657	2.4	2.0
MAN-H2	A635 (Fairfield Street)	385599	397631	2.9	2.0
MAN-J1	A57 (Mancunian Way)	384774	397492	0.7	1.0
MAN-J2	A57 (Mancunian Way)	384815	397450	1.4	2.0
MAN-J3	Grosvenor Street	384734	397268	2.4	2.0
MAN-J4	Grosvenor Street	384789	397314	1.4	2.0
MAN-J5	A6 (Downing Street)	384846	397417	0.7	2.0
MAN-J6	A6 (Downing Street)	384886	397415	4.5	2.1
MAN-J7	A6 (Ardwick Green South)	385124	397234	3.0	2.0
MAN-J8	A6 (Ardwick Green South)	385227	397142	2.4	2.0
MAN-K1	Lingfield Terrace	383737	397617	3.0	2.2
MAN-K2	Oakleigh Avenue	383508	397687	0.4	2.2
MAN-K3	A6143 (Liverpool Road)	383388	397716	0.7	2.1
MAN-L1	A56 (Chester Road)	382820	397214	0.6	2.0
MAN-L2	A56 (Chester Road)	382704	397132	2.8	2.0
MAN-L3	A56 (Chester Road)	382719	397160	1.7	2.0
MAN-L4	A56 (Chester Road)	382628	397111	1.7	2.0
MAN-L5	A56 (Chester Road)	382562	397061	1.4	2.0
MAN-M1	A665 (Great Ancoats Street)	384757	398618	2.3	2.0
MAN-M2	A665 (Great Ancoats Street)	384744	398594	1.4	2.0



Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
MAN-M3	A665 (Great Ancoats Street)	384837	398538	1.1	2.0
MAN-M4	A665 (Great Ancoats Street)	384995	398363	2.7	2.0
MAN-M5	A665 (Great Ancoats Street)	384980	398407	2.8	2.0
MAN-N1	A665 (Miller Street)	384104	399128	2.7	2.2
MAN-N2	A665 (Miller Street)	384214	399005	2.7	2.2
MAN-N3	A665 (Miller Street)	384351	398915	2.3	2.2
MAN-N4	A665 (Swan Street)	384490	398812	1.2	2.2
MAN-N5	A665 (Swan Street)	384543	398770	1.0	2.2
MAN-P1	A6042 (Trinity Way)	383546	399094	2.6	2.2
MAN-P2	A6042 (Trinity Way)	383347	399006	2.7	2.5
MAN-P3	A6042 (Trinity Way)	383381	399002	3.2	2.2
MAN-P4	A6042 (Trinity Way)	383179	398858	1.9	2.3
MAN-Q1	A6 (Chapel Street)	382548	398548	2.5	2.2
MAN-Q2	A6 (Chapel Street)	382641	398528	2.2	2.2
MAN-Q3	A6 (Chapel Street)	382709	398554	4.3	2.2
MAN-Q4	A6042 (Trinity Way)	382977	398468	2.5	2.1
MAN-Q5	A6042 (Trinity Way)	383020	398430	2.8	2.2
MAN-S1	A34 (Quay Street)	383255	398055	2.9	2.2
MAN-S2	A34 (New Quay Street)	383189	398129	1.0	2.2
MAN-S3	A34 (Quay Street)	383371	398024	0.7	2.2
MAN-T1	A5103 (Princess Parkway)	382286	389493	4.5	2.1
MAN-T2	A5103 (Princess Parkway)	382291	389730	1.0	1.6
MAN-T3	A5103 (Princess Parkway)	382326	389764	1.5	2.1
MAN-T4	A5103 (Princess Parkway)	382321	390246	1.5	2.0
MAN-T5	A5103 (Princess Parkway)	382379	390358	1.0	2.1
MAN-T6	A5103 (Princess Parkway)	382364	390497	1.0	2.1

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
MAN-U1	A555 (Ringway Road West)	382643	385497	2.5	2.1
MAN-U2	A555 (Manchester Airport Relief Road)	383157	385392	2.5	2.0
MAN-U3	Ringway Road	383415	385357	1.5	2.0
OLD-A1	A62 (Oldham Road)	392920	404700	2.7	2.0
OLD-A2	Wellington Street	393036	404835	1.7	2.0
OLD-A3	Rhodes Bank	393366	405122	1.6	2.0
OLD-A4	Victoria Street	393345	405029	2.2	2.0
OLD-A5	A62 (Bottom O'Th'Moor)	393518	405239	4.4	2.0
OLD-A6	B6194 (Shaw Road)	393634	405382	1.7	2.0
OLD-B1	A62 (Manchester Road)	390644	402798	2.7	2.0
OLD-B2	A62 (Manchester Road)	390347	402328	2.4	2.0
OLD-B3	A62 (Manchester Road)	390327	402276	0.6	2.0
ROC-A1	A664 (Edinburgh way)	388739	411799	2.5	2.0
ROC-A2	A664 (Edinburgh way)	388857	411769	2.6	2.0
ROC-A3	A58 (Manchester Road)	388496	411790	2.3	2.0
ROC-A4	A58 (Manchester Road)	388778	411974	1.1	2.0
ROC-A5	A58 (Manchester Road)	388944	412072	1.5	2.0
ROC-B1	A58 (St Mary's Gate)	389454	413521	2.4	2.0
ROC-B2	A680 (Spotland Road)	389293	413652	2.2	2.0
ROC-B3	A680 (Spotland Road)	389433	413623	1.7	2.0
ROC-B4	A58 (St Mary's Gate)	389830	413742	2.5	2.0
ROC-B5	A671 (Whitworth Street)	389845	413921	0.8	2.0
SAL-A1	A6 (Crescent)	381942	398703	3.1	2.0
SAL-A2	A6 (Crescent)	381852	398732	0.7	2.0
SAL-A3	A6 (Broad Street)	381631	398972	2.8	2.2
SAL-A4	A6 (Broad Street)	381463	399145	1.4	2.0
SAL-A5	A6 (Broad Street)	381459	399203	0.8	2.0
SAL-B1	A57 (Regent Road)	382135	397839	1.8	2.0
SAL-B2	A57 (Regent Road)	381921	397905	0.9	2.0
SAL-B3	A57 (Regent Road)	381531	398018	1.4	2.0
SAL-C1	A575 (Walkden Road)	374457	400988	2.1	2.0
SAL-C2	A572 (Worsley Brow)	374572	400613	2.4	2.0

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
SAL-C3	A572 (Worsley Brow)	374614	400561	1.4	2.0
STP-A1	B6104 (Carrington Road)	390496	391045	2.0	2.0
STP-A2	B6104 (Carrington Road)	390345	391049	2.2	2.1
STP-A3	Portwood Roundabout	390257	391024	4.0	2.1
STP-A4	A626 (St Marys Way)	390295	390834	2.1	2.2
STP-A5	A626 (St Marys Way)	390350	390719	3.0	2.0
STP-A6	A626 (St Marys Way)	390389	390547	3.5	1.9
STP-B1	A5145 (Travis Bow)	388550	390391	2.4	1.8
STP-B2	A5145 (Didsbury Road)	388341	390355	4.4	1.9
STP-B3	A5145 (Didsbury Road)	388109	390395	2.2	2.0
TAM-A1	A6140	392009	398060	2.0	2.1
TAM-A2	A635 (Manchester Road)	391913	398140	2.8	2.0
TAM-A3	A635 (Manchester Road)	392092	398186	2.2	2.0
TAM-B1	A635 (Stamford Street)	395574	398732	2.4	2.0
TAM-B2	A635 (Stamford Street)	395315	398791	3.4	2.1
TAM-B3	A635 (Stamford Street)	394994	398887	3.7	2.9
TAM-C1	A57 (Manchester Road)	390797	395629	1.3	2.1
TAM-C2	A57 (Manchester North Road)	391243	395581	1.8	1.9
TAM-C3	A57 (Manchester North Road)	391547	395558	2.5	2.4
TRF-A1	A56 (Cross Street)	378915	392794	2.0	1.9
TRF-A2	A56 (Cross Street)	378995	392869	2.0	2.1
TRF-A3	A56 (Cross Street)	378839	392639	2.8	1.9
TRF-B1	Winchester Road	377693	395120	0.4	1.9
TRF-B2	Winchester Road	377613	395111	1.1	1.9
TRF-B3	Winchester Road	377484	395125	1.2	2.0
TRF-C1	B5214 (Trafford Boulevard)	376841	397072	3.5	2.0
TRF-C2	B5214 (Trafford Boulevard)	376788	397036	3.1	2.1

Site name	Road section	Location		Distance from nearest kerb (m)	Diffusion tube height (m)
		X	Y		
TRF-C3	B5214 (Trafford Boulevard)	376670	396963	5.2	2.1
WIG-A1	Greenough Street	358870	405896	1.8	2.0
WIG-A2	Greenough Street	358695	405973	2.3	2.0
WIG-B1	A577 (Darlington Street)	358670	405311	2.0	2.0
WIG-B2	A577 (Darlington Street)	358460	405344	1.9	2.0
WIG-C1	A573 (Warrington Road)	360470	402401	2.0	2.0
WIG-C2	A58 (Platt Street)	360408	402719	1.8	2.0

"a,b,c" indicates triplicate diffusion tubes

## Appendix C. Annual mean NO<sub>2</sub> concentration calculations

Table C.1 12-month survey - mean NO<sub>2</sub> concentration calculations

Site name	Period weighted mean (raw data) (µg/m <sup>3</sup> )	Bias adjustment factor	Data capture (%)	National bias-adjusted 2019 annual mean concentration (µg/m <sup>3</sup> )
BLT 1-1	53.0	0.93	92	49.3
BLT 1-2	35.0	0.93	100	32.6
BLT 1-3	36.9	0.93	100	34.3
BLT 1-4	39.6	0.93	75	36.9
BLT 1-5	55.2	0.93	33	51.4
BUR 1-1	34.0	0.93	92	31.7
BUR 1-2	47.9	0.93	92	44.5
BUR 1-3	39.3	0.93	92	36.6
BUR 1-4	42.0	0.93	100	39.0
BUR 1-5	46.8	0.93	83	43.6
BUR1 (a)	28.7	0.93	83	26.7
BUR1 (b)	30.4	0.93	75	28.3
BUR1 (c)	27.9	0.93	67	26.0
MAN 1-1	38.4	0.93	100	35.7
MAN 1-2	38.5	0.93	92	35.8
MAN 1-3	53.9	0.93	100	50.1
MAN 1-4	40.7	0.93	67	37.9
MAN 1-5	44.1	0.93	100	41.1
MAN 2-1	48.7	0.93	100	45.3
MAN 2-2	43.2	0.93	100	40.1
MAN 2-3	47.1	0.93	75	43.8
MAN 2-4	59.0	0.93	50	54.8
MAN 2-5	68.9	0.93	100	64.1
MAN 3-1	42.2	0.93	92	39.2
MAN 3-2	38.9	0.93	100	36.2
MAN 3-3	40.6	0.93	83	37.7
MAN 3-4	47.2	0.93	100	43.9
MAN 3-5	44.7	0.93	92	41.6
MAN 4-1	46.5	0.93	92	43.2
MAN 4-2	40.0	0.93	42	37.2
MAN 4-3	64.3	0.93	25	59.8
MAN 4-4	46.7	0.93	92	43.4
MAN 4-5	59.1	0.93	83	55.0
SAL 1-1	51.1	0.93	67	47.6
SAL 1-2	47.2	0.93	58	43.9
SAL 1-3	50.4	0.93	42	46.9
SAL 1-4	47.8	0.93	92	44.4
SAL 1-5	46.2	0.93	25	43.0
STK5 (a)	25.3	0.93	100	23.5
STK5 (b)	26.0	0.93	100	24.2
STK5 (c)	24.6	0.93	100	22.9
STP 1-1	58.0	0.93	100	53.9
STP 1-2	57.7	0.93	92	53.7
STP 1-3	38.9	0.93	100	36.2
STP 1-4	47.9	0.93	92	44.5
STP 1-5	57.4	0.93	100	53.3
STP 2-1	57.7	0.93	83	53.7
STP 2-2	36.5	0.93	75	33.9

Site name	Period weighted mean (raw data) ( $\mu\text{g}/\text{m}^3$ )	Bias adjustment factor	Data capture (%)	National bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ )
STP 2-3	41.9	0.93	100	39.0
STP 2-4	55.2	0.93	100	51.3
STP 2-5	50.3	0.93	83	46.8
TAM 1-1	40.7	0.93	83	37.8
TAM 1-2	52.7	0.93	100	49.0
TAM 1-3	48.1	0.93	92	44.8
TAM 1-4	59.8	0.93	100	55.6
TAM 1-5	44.2	0.93	83	41.1
TRF 1-1	41.1	0.93	75	38.2
TRF 1-2	40.5	0.93	100	37.6
TRF 1-3	51.0	0.93	100	47.4
TRF 1-4	37.8	0.93	83	35.1
TRF 1-5	42.0	0.93	100	39.1
TRF 2 (a)	32.6	0.93	100	30.3
TRF 2 (b)	35.4	0.93	92	32.9
TRF 2 (c)	34.6	0.93	92	32.2

**Table C.2 7-month survey - mean NO<sub>2</sub> concentration calculations**

Site name	Period weighted mean (raw data) ( $\mu\text{g}/\text{m}^3$ )	Bias adjustment factor	Data capture (%)	Annualised and national bias-adjusted 2019 annual mean concentration ( $\mu\text{g}/\text{m}^3$ )
BLT-A1	46.9	0.93	57	N/A
BLT-A2	42.6	0.93	71	N/A
BLT-A3	38.9	0.93	86	39.8
BLT-A4	37.5	0.93	71	N/A
BLT-A5	48.5	0.93	100	48.5
BLT-A6	46.6	0.93	86	47.6
BLT-B1	33.0	0.93	71	N/A
BLT-B2	64.2	0.93	100	64.3
BLT-B3	59.5	0.93	57	N/A
BUR-A1	49.5	0.93	100	49.6
BUR-A2	55.1	0.93	86	59.1
BUR-A3	48.5	0.93	100	48.5
BUR-A4	61.4	0.93	100	61.5
BUR-A5	55.3	0.93	100	55.3
BUR-B1	62.1	0.93	100	62.1
BUR-B2	41.9	0.93	86	44.9
BUR-B3	36.4	0.93	100	36.4
BUR-C1	41.4	0.93	71	N/A
BUR-C2	37.6	0.93	71	N/A
BUR-C3	41.1	0.93	71	N/A
BUR-D1	52.1	0.93	86	55.9
BUR-D2	51.6	0.93	86	55.4
BUR-D3	42.1	0.93	100	42.1
MAN-1 (a)	56.9	0.93	100	45.1
MAN-1 (b)	60.2	0.93	100	45.8
MAN-1 (c)	58.6	0.93	100	N/A
MAN-A1	57.5	0.93	86	55.4
MAN-A2	52.0	0.93	29	N/A
MAN-A3	55.6	0.93	86	59.7
MAN-A4	50.4	0.93	86	54.1
MAN-A5	53.2	0.93	100	53.3

Site name	Period weighted mean (raw data) (µg/m <sup>3</sup> )	Bias adjustment factor	Data capture (%)	Annualised and national bias-adjusted 2019 annual mean concentration (µg/m <sup>3</sup> )
MAN-A6	62.0	0.93	71	N/A
MAN-A7	55.9	0.93	86	53.9
MAN-A8	55.9	0.93	86	55.9
MAN-B1	40.7	0.93	71	N/A
MAN-B2	60.0	0.93	57	N/A
MAN-B3	63.0	0.93	100	63.0
MAN-B4	59.9	0.93	86	57.8
MAN-B5	65.6	0.93	100	65.7
MAN-B6	60.2	0.93	86	60.2
MAN-C1	42.5	0.93	100	42.5
MAN-C2	48.1	0.93	71	N/A
MAN-C3	62.7	0.93	100	62.7
MAN-C4	64.6	0.93	100	64.6
MAN-C5	66.3	0.93	100	66.3
MAN-D1	56.4	0.93	100	56.5
MAN-D2	44.8	0.93	86	48.0
MAN-D3	55.1	0.93	86	59.1
MAN-D4	46.9	0.93	100	46.9
MAN-E1	47.2	0.93	71	N/A
MAN-E2	52.1	0.93	100	52.2
MAN-E3	48.5	0.93	100	48.6
MAN-F1	56.4	0.93	100	56.4
MAN-F2	63.5	0.93	86	68.1
MAN-F3	47.3	0.93	86	50.7
MAN-G1	51.1	0.93	86	56.4
MAN-G2	60.9	0.93	100	60.9
MAN-G3	56.0	0.93	100	56.1
MAN-H1	57.1	0.93	57	N/A
MAN-H2	50.2	0.93	100	50.2
MAN-J1	42.6	0.93	100	42.7
MAN-J2	49.5	0.93	100	49.5
MAN-J3	31.7	0.93	71	N/A
MAN-J4	36.3	0.93	71	N/A
MAN-J5	46.8	0.93	100	46.9
MAN-J6	50.2	0.93	71	N/A
MAN-J7	51.6	0.93	100	51.6
MAN-J8	64.2	0.93	86	61.9
MAN-K1	43.6	0.93	100	43.6
MAN-K2	49.3	0.93	100	49.4
MAN-K3	47.4	0.93	86	50.9
MAN-L1	52.6	0.93	86	56.4
MAN-L2	44.1	0.93	100	44.1
MAN-L3	56.0	0.93	57	N/A
MAN-L4	43.8	0.93	100	43.8
MAN-L5	49.2	0.93	71	N/A
MAN-M1	59.7	0.93	57	N/A
MAN-M2	75.5	0.93	71	N/A
MAN-M3	61.6	0.93	100	61.6
MAN-M4	54.0	0.93	100	54.1
MAN-M5	74.9	0.93	71	N/A
MAN-N1	70.6	0.93	43	N/A
MAN-N2	47.1	0.93	100	47.1

Site name	Period weighted mean (raw data) (µg/m <sup>3</sup> )	Bias adjustment factor	Data capture (%)	Annualised and national bias-adjusted 2019 annual mean concentration (µg/m <sup>3</sup> )
MAN-N3	44.1	0.93	100	44.1
MAN-N4	57.0	0.93	100	57.1
MAN-N5	66.2	0.93	100	66.3
MAN-P1	43.7	0.93	86	48.2
MAN-P2	63.4	0.93	100	63.5
MAN-P3	46.8	0.93	100	46.9
MAN-P4	50.0	0.93	86	55.2
MAN-Q1	48.9	0.93	86	52.5
MAN-Q2	55.2	0.93	100	55.3
MAN-Q3	45.4	0.93	71	N/A
MAN-Q4	48.4	0.93	71	N/A
MAN-Q5	46.4	0.93	100	46.4
MAN-S1	43.1	0.93	86	43.1
MAN-S2	46.0	0.93	86	45.9
MAN-S3	49.5	0.93	86	53.1
MAN-T1	53.1	0.93	100	53.2
MAN-T2	56.1	0.93	100	56.1
MAN-T3	69.7	0.93	100	69.7
MAN-T4	60.6	0.93	100	60.6
MAN-T5	75.8	0.93	100	75.9
MAN-T6	67.5	0.93	100	67.6
MAN-U1	54.3	0.93	100	54.4
MAN-U2	56.4	0.93	86	57.6
MAN-U3	30.3	0.93	100	30.3
OLD-A1	37.1	0.93	100	37.1
OLD-A2	44.8	0.93	43	N/A
OLD-A3	50.8	0.93	100	50.9
OLD-A4	53.9	0.93	100	53.9
OLD-A5	44.4	0.93	57	N/A
OLD-A6	50.3	0.93	100	50.4
OLD-B1	51.9	0.93	57	N/A
OLD-B2	43.7	0.93	86	46.9
OLD-B3	53.8	0.93	100	53.8
ROC-A1	52.8	0.93	57	N/A
ROC-A2	55.2	0.93	14	N/A
ROC-A3	37.9	0.93	71	N/A
ROC-A4	45.2	0.93	100	45.3
ROC-A5	56.6	0.93	86	60.7
ROC-B1	44.2	0.93	71	N/A
ROC-B2	43.1	0.93	86	46.2
ROC-B3	44.0	0.93	71	N/A
ROC-B4	40.1	0.93	100	40.1
ROC-B5	37.6	0.93	86	38.5
SAL-A1	41.3	0.93	57	N/A
SAL-A2	50.6	0.93	86	54.3
SAL-A3	43.1	0.93	43	N/A
SAL-A4	43.5	0.93	100	43.5
SAL-A5	54.3	0.93	100	54.3
SAL-B1	57.0	0.93	71	N/A
SAL-B2	45.4	0.93	100	45.4
SAL-B3	47.0	0.93	86	47.0
SAL-C1	41.1	0.93	100	41.1



Site name	Period weighted mean (raw data) (µg/m³)	Bias adjustment factor	Data capture (%)	Annualised and national bias-adjusted 2019 annual mean concentration (µg/m³)
SAL-C2	65.1	0.93	71	N/A
SAL-C3	62.2	0.93	86	66.7
STP-A1	35.6	0.93	43	N/A
STP-A2	43.5	0.93	100	43.5
STP-A3	48.2	0.93	100	48.3
STP-A4	40.4	0.93	100	40.5
STP-A5	44.1	0.93	86	47.3
STP-A6	70.2	0.93	86	75.3
STP-B1	46.1	0.93	100	46.2
STP-B2	49.0	0.93	100	49.0
STP-B3	43.3	0.93	86	44.3
TAM-A1	52.6	0.93	100	52.6
TAM-A2	50.6	0.93	71	N/A
TAM-A3	43.6	0.93	71	N/A
TAM-B1	36.9	0.93	86	39.6
TAM-B2	64.4	0.93	71	N/A
TAM-B3	40.5	0.93	86	39
TAM-C1	45.4	0.93	100	45.5
TAM-C2	68.7	0.93	57	N/A
TAM-C3	46.4	0.93	57	N/A
TRF-A1	42.9	0.93	43	N/A
TRF-A2	35.4	0.93	86	34.1
TRF-A3	41.2	0.93	86	44.2
TRF-B1	36.2	0.93	100	36.2
TRF-B2	35.8	0.93	100	35.9
TRF-B3	35.5	0.93	86	39.2
TRF-C1	38.2	0.93	86	41.0
TRF-C2	44.6	0.93	43	N/A
TRF-C3	47.3	0.93	71	N/A
WIG-A1	47.3	0.93	71	N/A
WIG-A2	36.4	0.93	71	N/A
WIG-B1	43.4	0.93	57	N/A
WIG-B2	42.1	0.93	86	45.2
WIG-C1	40.1	0.93	100	40.2
WIG-C2	41.2	0.93	43	N/A

"N/A" indicates that monitoring data capture was lower than 75% and therefore the data was not annualised

**Table C.3. Raw monthly mean NO<sub>2</sub> concentrations (µg/m³) for 12-month survey sites**

Site	Monthly monitoring period											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
BLT 1-1	53.4	56.9	45.2	62.3	-	45.4	41.4	49.7	57.9	58	58.9	55
BLT 1-2	47.3	44.1	27.1	30.7	28	29	28.8	34.3	34.8	34.7	43.6	39.9
BLT 1-3	50.5	37.5	32.3	31.3	32.9	28.3	32.5	33.3	38.2	31.2	50.7	45.8
BLT 1-4	-	-	36.6	46.3	-	32.9	35.1	39.9	30	41.5	50.2	46.4
BLT 1-5	71.7	58.8	40.4	51.9	-	-	-	-	-	-	-	-
BUR 1-1	47.6	39.8	24.7	34.3	30.4	25.7	34	27.5	37	37.1	-	38.3
BUR 1-2	57.7	56.1	37.4	47.6	44.7	47.9	51.8	48.3	53.8	40.4	-	43.3
BUR 1-3	49.2	-	40.3	44.1	33.9	36.2	31.7	30.1	41.3	41	47.7	38.2
BUR 1-4	65.9	53.6	34.7	44.4	35.6	37.8	34.8	35.2	43	40.9	42.1	38.5
BUR 1-5	50.8	33.6	43.9	62.2	47.8	-	46.4	42.4	51.9	43	47	-
BUR1 (a)	36.3	30.4	23.4	29.5	20.5	24.1	20.3	-	-	31.3	42.2	30.3
BUR1 (b)	42.8	29.7	19.5	31	-	27.8	21.5	-	-	33.4	38.5	30.9
BUR1 (c)	37.4	30.2	22.7	-	-	20	22	22.7	-	-	38.2	31.7
MAN 1-1	50.5	47.7	31.2	41.1	31.8	28.4	29.6	32	41.3	34.3	49.7	46.4

Site	Monthly monitoring period											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
MAN 1-2	36.6	44.8	30.2	35.3	32.3	30.8	-	33.1	43.2	40.6	52.9	45.3
MAN 1-3	62.1	63.3	36.8	61.6	47.7	39.8	49.9	50.2	64.3	51.5	68.4	54.6
MAN 1-4	-	-	-	-	40.7	41.9	37	40.2	39.6	37.9	47.1	41.8
MAN 1-5	53.3	53.6	38.7	32.1	44.3	43.3	40.1	45.2	44.6	44.3	48.8	41.8
MAN 2-1	48.1	45.5	44.6	45.8	45.1	49.3	46.6	47.3	47.3	46.5	65.8	54
MAN 2-2	54	41	37.2	41.8	37.5	38.3	38	35.5	50	45	51.8	48.8
MAN 2-3	-	47.8	-	45.3	44.1	46.5	45.5	46.5	49.2	-	47.9	50.7
MAN 2-4	-	-	59.1	59.5	60.1	56.6	-	-	59.3	59	-	-
MAN 2-5	79.2	73.8	53.9	77.5	63.6	61.3	59.4	65.7	74.6	66.9	80.2	74.3
MAN 3-1	52	52.6	34	40.9	31.9	30.9	39.3	-	-	42.4	52.5	48.8
MAN 3-2	47.3	45.2	32.2	34	30.1	33.9	31.4	34.7	42.6	41.9	52.5	43.1
MAN 3-3	-	48.2	33	39.6	33	34.4	34.3	36.6	47.9	42.8	57.6	-
MAN 3-4	51.2	49.5	39.2	52.6	42.3	48.3	44.8	45.7	54.2	44.9	50.6	44.3
MAN 3-5	-	61	35.1	39	36.6	36.4	36.6	44.2	48.3	45.5	58.7	52.5
MAN 4-1	50	44.2	40.5	-	41.9	43.3	44.8	43.8	51.4	51.7	47.4	52.6
MAN 4-2	-	-	-	-	-	-	30.8	32.7	48.5	47.7	38.6	-
MAN 4-3	-	-	-	-	-	-	-	-	-	51.8	79.6	63.3
MAN 4-4	58.8	-	34.8	49.4	40.8	43.7	43.6	46.9	54.1	39.4	59.6	44.5
MAN 4-5	-	76.7	42.7	60	55.5	53.7	50.3	-	72.1	53	66.1	63.3
SAL 1-1	51.7	42.6	-	-	-	-	43	49.7	58.7	44.7	61.4	56.6
SAL 1-2	65.5	42.6	39	43.3	36.9	-	46.2	-	56.9	-	-	-
SAL 1-3	60	54.1	-	42	-	-	-	38.9	-	-	58.1	-
SAL 1-4	57.4	-	40.5	50.7	39.3	40.7	35.8	43.8	53.4	53.6	61.2	50.1
SAL 1-5	-	-	-	-	-	-	38.8	46.9	-	52.1	-	-
STK5 (a)	30.1	23.4	23.2	29.8	21.2	21.3	19.1	19.8	27.7	32.1	34	22.4
STK5 (b)	31.9	25.4	25	30.6	18.7	20.6	19.4	19.2	27.4	38.2	34.6	21.9
STK5 (c)	34.2	24.3	22.1	28.8	20	21.4	20	19.9	26.6	28.1	30.4	20.1
STP 1-1	53.6	51.4	54.1	64.8	62.2	65.8	59.5	59.7	57.3	51.7	53	62.9
STP 1-2	71.9	62	40	57.6	57.6	57.4	58.5	57.7	59.9	-	64.2	50.4
STP 1-3	67.5	62.7	24.9	36.8	29.5	31.9	30.2	30.6	38.3	38.4	44.4	36.5
STP 1-4	70.3	-	32.4	37.9	43.1	46.5	44.9	46.5	46.1	61.5	52.4	46.1
STP 1-5	69.1	57.8	49.9	62.1	53.2	60.9	58.9	55.9	64.5	52.8	55.5	49.1
STP 2-1	-	88.6	45.2	64.5	46.4	50.3	53.1	48.9	58.3	-	67.2	60.9
STP 2-2	-	39.4	32.2	32.8	32.6	-	32.5	-	38.8	35	44.4	41.7
STP 2-3	57.6	54.5	30.2	37.1	33.9	40.1	36.1	42.1	42.4	38.7	48.8	44.9
STP 2-4	52.1	71.2	46.9	49.2	56.6	53.6	54.2	58.9	61.3	49.2	53.6	56.7
STP 2-5	51	-	75.5	51.2	-	45.1	43.7	38.1	45.6	45	55.7	51
TAM 1-1	53.4	44.7	32.4	38.8	33.8	39	-	-	36.4	41.4	46.1	43.3
TAM 1-2	64	59.1	41.8	49.2	45.5	55.8	54.1	55.9	53.5	44.8	56.5	54.7
TAM 1-3	54.6	50.9	36.2	49	44.7	46.8	50.8	49	53.2	-	51	44.7
TAM 1-4	62.4	61.8	46.8	60.4	61.5	57.1	62.2	65	62.6	50.9	66.5	62.1
TAM 1-5	50.3	53.2	36.3	39.7	-	40.5	-	45.9	45.1	34.1	52.7	46.8
TRF 1-1	-	-	36.7	36.4	40.9	40.7	41.3	45.3	-	41.7	44.1	42.5
TRF 1-2	51.8	46.7	30	36.3	38.5	37.5	40.1	44.2	41.8	41.4	41.4	37
TRF 1-3	60	59.9	42.6	44.7	51.3	46.5	50.9	50.6	53.3	41.7	57.1	55.4
TRF 1-4	-	-	27.3	40.5	30	31.4	34.3	37.2	45	37.9	50.7	45.1
TRF 1-5	53.7	52.2	32.4	46	37.3	30.9	31.9	36	43.5	42.3	53.6	47.8
TRF 2 (a)	42.9	42.5	28.4	27.1	29.3	27.5	27	29.7	33.8	32.5	39.5	32.6
TRF 2 (b)	38.5	65.4	29	29.8	26.5	-	26.6	28.9	34.7	34.9	39	39.4
TRF 2 (c)	47.9	44.1	24.9	31.4	-	28.1	28.2	28.8	34	32.6	44.4	38.7

"-" indicates tube was inaccessible, missing or erroneous

Table C.4. Raw monthly mean NO<sub>2</sub> concentrations (ug/m<sup>3</sup>) for 7-month survey sites

Site	Monthly monitoring period						
	P1	P2	P3	P4	P5	P6	P7
BLT-A1	38.1	-	43.1	-	53.2	-	53.1
BLT-A2	-	36.4	38.2	43.2	46.9	48.2	-
BLT-A3	-	28.7	29.7	35.5	44.5	52.6	43.4
BLT-A4	34.5	-	35.3	37.2	40.4	-	40.1
BLT-A5	38	39.3	46.2	49.8	50.1	60	56

BLT-A6	-	39.1	41.5	48.2	45.4	64.1	41.8
BLT-B1	32.5	-	31.9	35.6	34.5	-	30.3
BLT-B2	60.2	68.1	66.6	58.9	57.2	69.3	70.6
BLT-B3	61.7	-	58.9	60.4	-	56.9	-
BUR-A1	42.7	44.8	46	52.3	49.3	59.8	52
BUR-A2	46.8	-	49	63.7	57.9	59.7	52.8
BUR-A3	39.3	47.2	42.5	50.5	50.8	58.5	51.1
BUR-A4	54.2	66.3	53.8	47.8	67.2	72.3	70.8
BUR-A5	46.3	50.9	60.8	53.9	60.8	65.3	48.1
BUR-B1	47.4	54.5	56.9	76.3	62.6	71.9	63.5
BUR-B2	33.3	-	35.5	44.4	46.6	51.9	39.6
BUR-B3	33.6	34.8	34.9	36	38.2	44.2	33.1
BUR-C1	-	-	37.8	42.9	40.7	45.8	40.2
BUR-C2	29.2	34.1	-	-	41.8	48.5	34.3
BUR-C3	30.4	-	39.1	44.3	-	41.8	49.6
BUR-D1	39.6	42.6	45.4	49.2	-	93.2	44.5
BUR-D2	48.7	43.2	47.2	55.6	-	55.3	59.6
BUR-D3	36	38.6	38.4	48.1	49.2	58.7	25
MAN-1 (a)	49.8	58.3	59.1	56.5	64.5	57.4	51.8
MAN-1 (b)	53.1	57	62	60.7	66.7	64.1	56.9
MAN-1 (c)	50.2	57.6	60.5	58	64.5	60.2	58.9
MAN-A1	50.8	48.7	-	59	68.9	71.5	45
MAN-A2	52.5	-	51.5	-	-	-	-
MAN-A3	46.7	-	46.6	59.2	60.3	64.4	56.7
MAN-A4	45.9	-	46	47.6	55.4	57.3	50.6
MAN-A5	47.8	48.4	46.6	57.7	57.2	58.3	56.2
MAN-A6	52.4	54.3	-	64.5	67.9	70.1	-
MAN-A7	53.8	53.7	-	57	57.6	58.2	54.7
MAN-A8	51	55.4	52	-	57.9	61.5	57.9
MAN-B1	39.2	33.7	-	42.9	46.8	-	40
MAN-B2	50.8	-	59.2	61.3	-	69	-
MAN-B3	57.2	64.1	52.9	64.8	72.6	68.4	61
MAN-B4	50.5	59.8	-	64.6	56.4	62.4	65.7
MAN-B5	59.9	65.2	61.2	67.2	72.5	70.1	62.8
MAN-B6	52.5	62.2	56	-	61.3	68.7	61
MAN-C1	36.2	39.3	37.8	41.7	46.9	52.1	43.8
MAN-C2	43.2	47.3	-	-	51.2	52.6	45.9
MAN-C3	53.1	88.8	46.2	46.2	78	71.9	57.8
MAN-C4	62	66.7	64.3	61.9	66	67.7	63.8
MAN-C5	47.2	75.6	51.2	71.4	71.4	69.2	78.7
MAN-D1	50.7	61	55.1	56.7	60.4	54.7	56.1
MAN-D2	37.9	44.4	41.6	47.8	-	47.4	49.4
MAN-D3	48.3	53.6	53.6	57.9	-	63	54.3
MAN-D4	34.7	45	45	43.2	50.2	59.1	51.6
MAN-E1	41.2	46.6	44.6	53.5	-	-	49.4
MAN-E2	44.1	50.5	51.5	54.4	52.4	54.9	57
MAN-E3	42.7	44.8	47.7	49.3	50.6	55.7	48.9
MAN-F1	49	56.1	49.6	56.9	58.7	60.8	64
MAN-F2	55.9	61.8	62.5	65.9	-	65.5	68.9
MAN-F3	37.8	-	46	47.2	50.6	52.7	49.3
MAN-G1	43.5	48.7	49.8	49.3	56.3	-	58.6
MAN-G2	52.7	59.3	58.7	68	60.6	70.1	56.3
MAN-G3	49.3	55.2	55.7	58	57.2	61.9	54.6
MAN-H1	-	-	-	53.2	56.3	57.6	61.8
MAN-H2	45.8	46.8	48	42.6	57.3	60.3	51.3
MAN-J1	31.8	34.7	37.2	49.4	54.5	46	43.1
MAN-J2	39	39.8	43.6	46.7	53.6	78.5	46.1
MAN-J3	27.9	27.4	30.5	-	41.7	-	29.8
MAN-J4	-	28.5	31.6	39.4	44.6	-	36.3
MAN-J5	40.1	39	39.9	45.2	58.2	57.6	47.7
MAN-J6	-	46.1	49.2	47.8	50.1	58.4	-
MAN-J7	46.7	48.6	51.8	49.9	50.7	60.4	53.5
MAN-J8	61.1	62.8	-	67	59.4	70.2	65.1
MAN-K1	35.9	38.1	40.7	45.8	52.6	46	45.2
MAN-K2	49.9	49.7	46.3	45.5	56.5	52.8	44.7
MAN-K3	44.9	-	39.3	47.7	57.9	54.8	39.8
MAN-L1	51.7	-	49.1	44.8	66.4	57.8	45.8

MAN-L2	38.6	37	36.8	43.7	57.5	51.7	42.9
MAN-L3	54.1	51	47.6	-	70.7	-	-
MAN-L4	39.4	40	45.1	44.6	49	58.1	29.9
MAN-L5	40.4	-	39.8	-	59.4	57.4	49.1
MAN-M1	60.1	-	56.2	63.4	-	-	58.8
MAN-M2	73.2	82.7	74.9	-	71.7	-	75.8
MAN-M3	61.1	59.4	62.6	54.4	71.8	57.1	64.3
MAN-M4	50	58.4	57.4	56	47.4	57.6	51.6
MAN-M5	-	78.6	74.4	-	73.5	68.4	79.5
MAN-N1	-	76.3	-	65.3	-	71.1	-
MAN-N2	42.6	45.7	42.5	47	45.2	55.7	51.9
MAN-N3	39.7	40.6	39.6	43	48.6	52.6	44.6
MAN-N4	51.7	56.5	56.5	57.8	54.9	65.1	57
MAN-N5	57.9	70.7	61.7	78.3	67.5	64.3	62
MAN-P1	38.6	38.9	39.4	42.9	50.4	-	51.5
MAN-P2	51.4	61	62.2	72	63.9	67.2	65.2
MAN-P3	43.4	42.6	42.4	46.5	54.5	55	43.2
MAN-P4	38.7	53	46.7	55.7	56.2	-	48.8
MAN-Q1	45.3	49.3	42.7	52.4	-	58.6	45.8
MAN-Q2	48.6	56	54.2	56.1	54.6	61.1	56.4
MAN-Q3	43.7	42.4	43.3	43.7	53.6	-	-
MAN-Q4	41.4	46	45.6	-	-	57.4	52.2
MAN-Q5	39	43.8	45.7	48	54.7	47.1	45.5
MAN-S1	43.1	40.7	40.9	-	53.1	42.6	37.5
MAN-S2	42.6	42.2	40.4	46.8	49.8	54.1	-
MAN-S3	45.1	-	44.2	53.1	57.8	50.3	45.7
MAN-T1	46.4	45.7	50.8	50.5	53.8	66.9	58.4
MAN-T2	49.8	49.6	51.1	63.7	63.1	63.4	50.7
MAN-T3	68.4	63.9	70.2	66.5	78.2	72.6	67.3
MAN-T4	48.4	51	48.1	66.1	72.9	72.9	64
MAN-T5	74.6	78.6	72	77.8	73.9	75.1	79
MAN-T6	58.6	66.9	66.9	66.1	74.5	75.8	63.6
MAN-U1	48.6	53.9	63.5	51.7	53.8	56.2	52.2
MAN-U2	-	59.5	59	58.8	54.5	59.1	47
MAN-U3	43.5	25.3	24.5	25.9	32.5	35.1	26.2
OLD-A1	33.3	32.5	37.7	36.4	40.4	41	37.9
OLD-A2	-	36.7	-	43.6	-	54.2	-
OLD-A3	41.2	45.3	50.4	48.6	55.1	60.6	54.7
OLD-A4	57	56.4	55.7	49.4	60.8	58.9	39
OLD-A5	-	41.6	-	-	41.9	52.8	41.8
OLD-A6	45.1	46.5	48.7	54.1	49	55.6	53.1
OLD-B1	41.5	-	-	58.2	59.2	47	-
OLD-B2	33.7	-	47.1	41.9	43.3	48.3	48.1
OLD-B3	39.9	49.6	48.7	58.9	58.9	62.8	57.3
ROC-A1	-	-	-	53.8	52.4	47.5	57.1
ROC-A2	-	-	55.2	-	-	-	-
ROC-A3	36.3	37	37.5	40.1	-	-	38.5
ROC-A4	38.1	44.1	43.3	46.8	48.4	50.2	45.6
ROC-A5	48.7	-	47.7	71.6	60.1	60	50.2
ROC-B1	-	-	36.9	48.7	48.2	43.6	43.3
ROC-B2	37.6	-	37.4	41.3	47.1	53	42.8
ROC-B3	40.5	-	38.8	48	44.1	48.8	-
ROC-B4	35	37.3	35.7	43.5	46.9	41.6	39.8
ROC-B5	-	30	29.1	39.9	39.4	46	41.8
SAL-A1	-	-	34.3	-	45.9	46.8	38.6
SAL-A2	49.3	-	45.9	56.5	56.5	59.2	35.7
SAL-A3	-	33	-	-	-	50.5	45.7
SAL-A4	46.6	39.1	35.1	41.8	52.3	51.6	38.1
SAL-A5	47.7	51.6	51	57.4	57.5	53.8	60.5
SAL-B1	42.4	44.3	-	-	78.1	61	57.1
SAL-B2	35.3	41.7	41.1	44	49.5	54.8	51.7
SAL-B3	36.5	38.8	44	-	52.1	59	51.3
SAL-C1	31.6	33.6	35.9	42.4	46.4	53.2	44.5
SAL-C2	43.1	-	40.5	92.5	-	94.7	54.3
SAL-C3	48	-	83	45.4	49.8	52.9	95
STP-A1	35.1	30.7	-	-	40.3	-	-
STP-A2	41.2	43.2	44.2	40.6	44.4	45.5	45.6

STP-A3	44.9	45.7	42.7	48.9	54.4	51.7	49.2
STP-A4	37.2	36.4	36.4	39	48.7	46.8	38.4
STP-A5	43.7	42.4	43.9	45.4	-	48	41
STP-A6	65.4	-	65.3	70.8	78.6	73.9	66.6
STP-B1	31.6	43.2	43	44.6	50.6	59.5	50.7
STP-B2	43.7	46.1	49	49	44.7	60	51.2
STP-B3	-	36.6	37.8	42.2	48.9	49.1	45.2
TAM-A1	45.9	49.9	55.7	50.6	50.8	59.6	55.7
TAM-A2	40.5	50.3	53	54.3	-	54.5	-
TAM-A3	33.8	-	37.5	35.3	-	74.1	40.1
TAM-B1	39.7	-	33.1	38.4	46.6	23.2	39
TAM-B2	67.2	71.6	-	66.1	61.3	-	56.3
TAM-B3	37.1	38.1	-	39.9	41.6	45.3	40.9
TAM-C1	42.5	42.5	43.3	44.9	55.9	44.8	43.2
TAM-C2	52.6	-	77	-	-	68.4	75.9
TAM-C3	42.3	46.3	-	-	-	44.5	52.3
TRF-A1	-	-	38.2	-	53	-	36.9
TRF-A2	27.7	35	-	34.8	40	39.4	35.4
TRF-A3	34.9	27.9	32.1	53	-	51.7	47
TRF-B1	30.7	29.1	33.2	35.6	44	45.4	35.2
TRF-B2	31.9	32	34.8	33.7	39.8	41.2	37.4
TRF-B3	30.6	28.4	28.1	40.1	46.9	-	37.6
TRF-C1	38	30.1	41.8	43.5	-	42.6	32.1
TRF-C2	-	-	39.7	48.9	-	-	45.1
TRF-C3	-	40.6	42.9	49	51.2	-	52.3
WIG-A1	38.1	40	-	50.2	-	55.3	52.7
WIG-A2	31.7	28.9	31.8	-	1.7	52.9	37.5
WIG-B1	43.9	38.8	-	-	-	50.2	40.7
WIG-B2	37.3	-	39.4	43.9	48.8	41.4	41.1
WIG-C1	36.5	36.9	37.4	41.9	40.2	46.9	41.2
WIG-C2	30.5	-	-	-	-	53.6	40

“-“ indicates tube was inaccessible, missing or erroneous